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Simplified Weather Criteria for Apple Scab Infection

Introduction

In a paper[1] entitled "The Duration of Surface Wetness" presented at the XVth International Horticultural Congress at Nice it was suggested that the duration of surface wetness might be equivalent to the duration of relative humidity above 90 per cent.

Experience of recent years has shown that this is substantially true with the result that charts showing Mills periods derived from wetness recording instruments were very similar to those showing (Smith) periods derived from humidity measurements. This was discussed in detail in the June 1961 issue of Plant Pathology.[2]

This year further evidence supporting this hypothesis comes from work carried out by T.F. Preece at the Plant Pathology Laboratory. Figure 1. (reproduced by permission of Mr. Preece) shows the plot of relative humidities and the trace of a wetness recorder at Harpenden on April 19-20th, 1961. Both methods, by the Mills criteria, indicated infection periods of approximately the same length. A large ascospore release was observed, and all ten root-stocks exposed to this release showed subsequent signs of infection; 211 lesions were observed within a fortnight, although the plants had been protected from any further possible infection.

Present Investigation

Evidence of this character enables the examination of past records of hourly observations of humidity to proceed with a fair degree of confidence. The March, April and May records from Mildenhall in East Anglia for the years 1944-1955 were consulted and the occurrence of significant weather noted. There were 180 occasions of continuous rain and showers, of these 74 were accompanied and followed by weather which satisfied the Mills criteria for infection; the remaining 106 were therefore not significant.

The purpose of the investigation was to analyse these data to find simpler criteria which did not demand continuous observation of the weather and would thus be suitable for individual use in orchards.

Analysis

If the significant occasions are considered when there was less than 12 hours continuous rain and the time of start of the rain plotted against the duration of rain, the result is illustrated in Figure 2.

It is immediately obvious that there is an area to the bottom left hand side of the graph which contains no plots. In other words we can draw an envelope line from the point 12 hours-0600 G.M.T. to the point 1 hour-1700 G.M.T. to the right of which all significant plots must lie. In other words for significant weather:-

If it begins to rain at 0600 G.M.T.,	it has to rain for 12 hours
1000 G.M.T.,	8 hours
1400 G.M.T.,	4 hours
1600 G.M.T.,	2 hours

In all cases the rain has still to be falling at 1700 G.M.T..
If all the occasions when rain started between 0600h and 1700h are

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examined and periods of 12 hours continuous rain or more eliminated, it is found that in 50 such occasions, all the significant periods occurred when the temperature was 50°F or above at 1700 hours. The following rule is therefore proposed:-

(i) If rain starts to fall during the day, a significant period is likely if the rain is still falling at 1700 G.M.T. and the temperature at that time is 50°F or above.

The full analysis is:-

Total occasions	Significant occasions		Not significant occasions	
	Successful	Failures	Successful	False Alarms
50	22	0	23	5

No similar rule can be found for rain which starts to fall during the evening or night, for on many significant occasions the rain stops during the night and it is not still falling the next morning when it could be observed by a fruit-grower. In all these cases, however, the significant period persisted until 0800 G.M.T., i.e. at that time the leaves were still wet, and moreover, the temperature at that time was again 50°F or above. The second rule is then proposed as:-

(ii) If rain starts to fall during the evening and nights, a significant period is likely if the leaves are still wet at 0800 G.M.T and the temperature at that time is 50°F or above. Figure 2 also shows that no significant period occurred due to rain (of less than 12 hours duration) which started after 2300 G.M.T. It is however unrealistic to expect a fruit grower to be aware if it is not raining at 2400 G.M.T. (0100 B.S.T.).

Again eliminating occasions when rain fell for 12 hours or more, the full analysis is:-

Total occasions	Significant occasions		Not significant occasions	
	Successful	Failures	Successful	False Alarms
69	13	0	50	6

There remained to be considered the occasions when rain fell for over 12 hours, sometimes with temporary breaks. Analysis indicated that the following rule was valid:-

(iii) On occasions when rain falls for 12 hours or more a significant period is likely when the 1700h or 0800h temperature is 46°F or above. If the rain falls for 24 hours or more the critical temperature can be lowered still further to 44°F. The full analysis is:-

Rain duration	Total occasions	Significant occasions		Not significant occasions	
		Successful	Failures	Successful	False Alarms
12-24 hours	46	28	0	15	3
over 24 hours	15	10	1	4	0

The one failure occurred when there were two spells of 24 hours rain within a period of 85 hours wetness. The observed temperature was 36°F on the first morning. The date was the 8th-12th March, 1951 when it was highly improbable that any fruit buds had burst.

Of the 14 false alarms, half were 'near misses' by reference to the Mills Criteria; the remaining 7 (or less than 4 per cent) were misleading. These false alarms occurred 3 times in March, 5 times in April and 6 times in May, and most of the near misses were in the earlier months.

Conclusion

For growers who are able to take temperature observations twice

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per day at fixed hours, the following criteria can be suggested to indicate the probability of significant weather for apple scab:-

A significant period is likely if

(a) Rain starts to fall during the day, is still falling at 1700 GMT and the temperature at that time is 50°F or above.
(b) Rain starts to fall during the evening or night, and the leaves are still wet at 0800 G.M.T. with a temperature at that time of 50°F or above.
(c) Rain falls for 12 hours or more and the temperature at either 1700 G.M.T. or 0800 G.M.T. is 46°F or above
(d) Rain falls for 24 hours or more and the temperature at either time is 44°F or above
(e) Rain falls for 36 hours or more and the temperature at either time is 36°F or above.

References

1. SMITH L.P. The Duration of Surface Wetness
Proc. XVth International Horticultural Congress
(as yet unpublished)
2. PRENCE T.F. and SMITH L.P. Apple Scab Infection Weather in England Wales 1956-60
Plant Pathology. Vol 10 No.2 June 1961. pp 43-51

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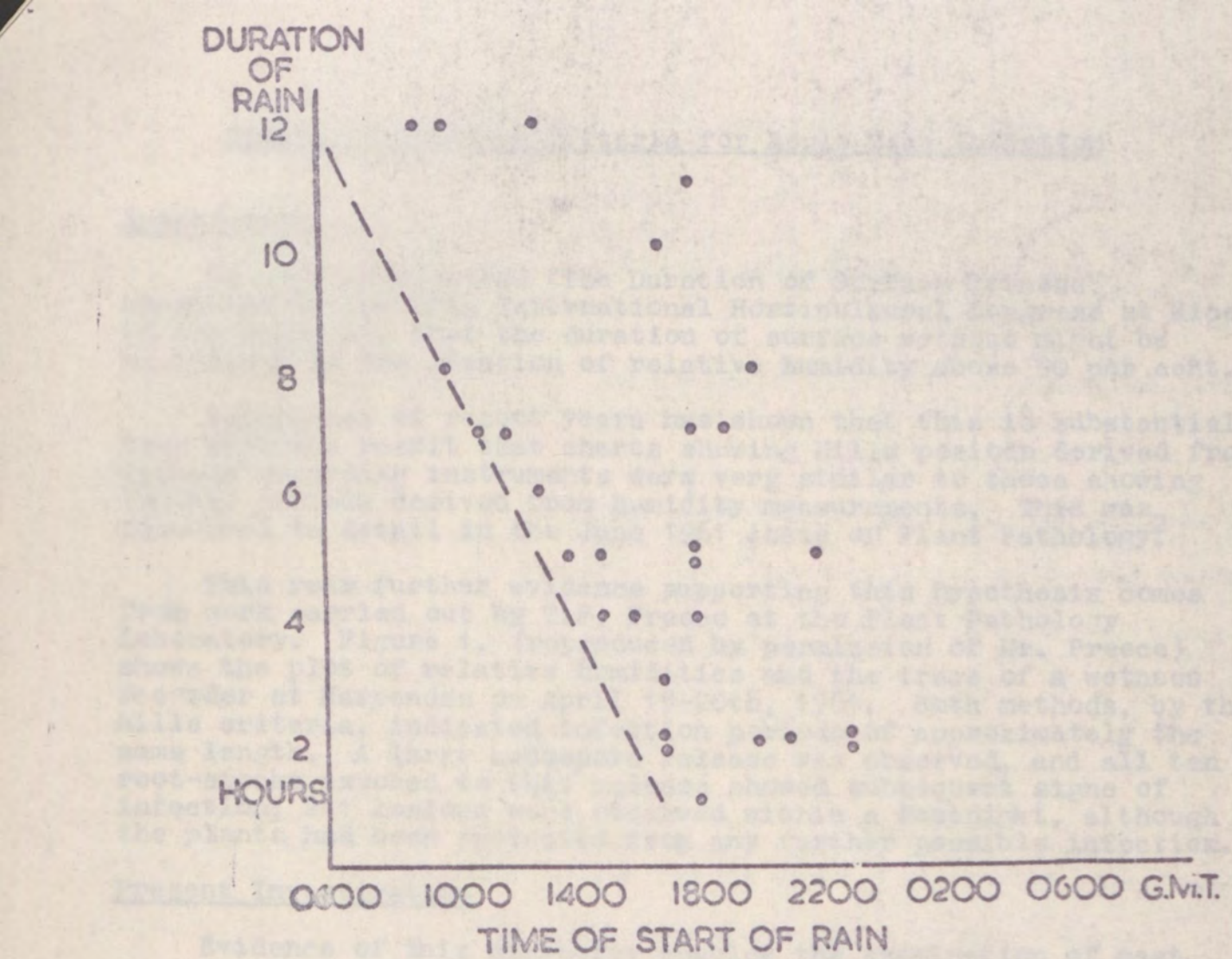
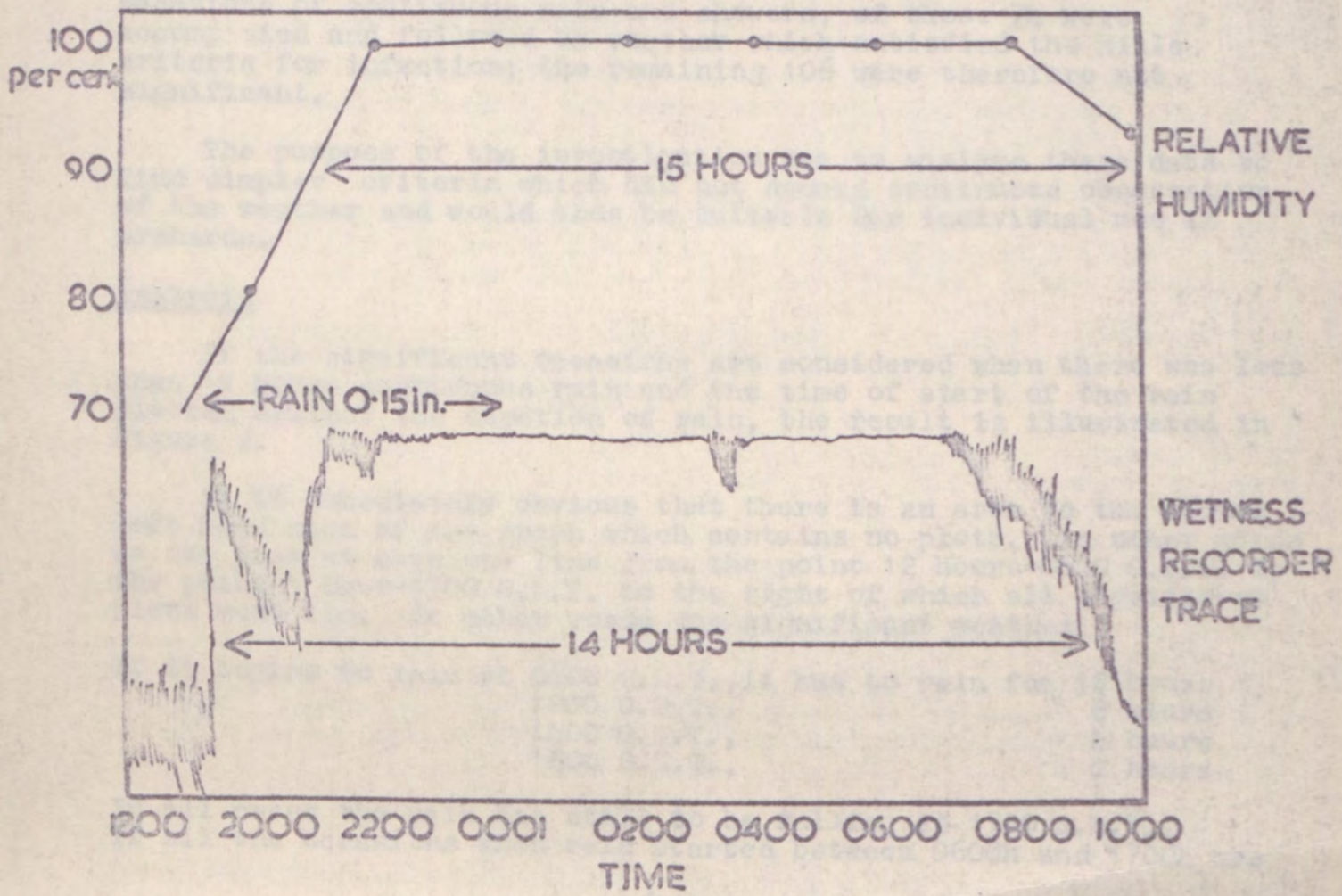

DURATION OF RAIN
12
10
8
6
4
2
HOURS
0000 1000 1400 1800 2200 0200 0600 G.M.T.
TIME OF START OF RAIN


100 per cent
90
80
70
15 HOURS
RELATIVE HUMIDITY
RAIN 0·15 in.
14 HOURS
WETNESS RECORDER TRACE
1200 2000 2200 0001 0200 0400 0600 0800 1000
TIME